MULBERRY STREET VIADUCT HAER No. PA-497
Pennsylvania Historic Bridges Recording Project - II
Spanning Paxton Creek and Cameron St. (State Rt. 230) at Mulberry St. (State Rt. 3012)
Harrisburg
Dauphin County
Pennsylvania

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
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MULBERRY STREET VIADUCT

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Location:	Spanning Paxton Creek and Cameron St. (State Rt. 230) at Mulberry St. (State Rt. 3012), Harrisburg, Dauphin County, Pennsylvania.
USGS Quadrangle:	Harrisburg West, Pennsylvania (7.5-minute series, 1987).
UTM Coordinates:	18/340550/4458220
Dates of Construction:	1908-09.
Designer:	James H. Fuertes, engineer, City of Harrisburg Board of Public Works.
Builder:	McCormick and Company (Philadelphia).
Present Owner:	Pennsylvania Department of Transportation.
Present Use:	Vehicular bridge.
Significance:	An early and artful example of reinforced concrete, the Mulberry Street Viaduct was shaped by community and civic demands, the flexibility of poured construction, and the talented design of James H. Fuertes. This bridge links not two, but three locations: the industry of Paxton Creek valley, residences on Allison's Hill, and Harrisburg's downtown. When completed, it was among the world's longest and most complex reinforced concrete bridges.
Historian:	Ben A. Shackleford, August 1998.
Project Description:	The Pennsylvania Historic Bridges Recording Project II was co-sponsored during the summer of 1998 by HABS/HAER under the general direction of E. Blaine Cliver, Chief; the Pennsylvania Department of Transportation, Bureau of Environmental Quality, Wayne W. Kober, Director; and the Pennsylvania Historical and Museum Commission, Brent D. Glass, Executive Director and State Historic Preservation Officer. The fieldwork, measured drawings, historical reports and photographs were prepared under the direction of Eric DeLony, Chief of HAER.

Introduction

Spanning the shallow valley cut by Paxton Creek parallel to the Susquehanna at Harrisburg, the Mulberry Street Viaduct links downtown with suburban districts to the east, as well as the industrial region spread across the alluvial plain of Paxton Creek. To accomplish this, the bridge must connect not two, but three places. The Mulberry Street Viaduct spans a valley little more than 1,800 feet wide, and never more than 70 feet deep. It is not much of a valley in geological terms, but it was important real estate in Pennsylvania's burgeoning capital. To understand how the bridge took its current shape, one must begin with the river.

Harrisburg

As a river town, alluvial geography has shaped Harrisburg physically, economically, and socially. The Harris family began operating a ferry across the Susquehanna in 1733. As late as 1784, little more than a single dwelling existed on the current site of Harrisburg. In 1785, John Harris laid out the town for a newly created Dauphin County.[1] Situated in the foothills of mountainous east central Pennsylvania, it was the site of an early gateway across the Susquehanna River to the natural wealth of south central Pennsylvania. Bisecting the state, the Susquehanna flowed into Harrisburg from the north, passing with light commerce southward. At the point where the Susquehanna emerges from the Appalachian mountains, riparian paths through gorges, carved by centuries of flowing water, formed the crossroad significance of Harrisburg before the revolution.

Because it is a slow-moving, shallow river, the Susquehanna shaped the history of Harrisburg more as an obstacle than as an artery of transit. Harrisburg was the best point to cross the river and begin negotiating mountainous central Pennsylvania. Thus, the city became a point of convergence for smaller networks of transportation within the state's interior, linking them (at high water) by river to the ocean port of Baltimore, and ultimately by canal and by rail to the commercial hub of Philadelphia. From colonial times, geography determined Harrisburg's location and function as a gateway for people moving inland and a vital distribution link for commerce.

Railroads made Harrisburg into the transportation hub that marked it as a commercial center during the second half of the nineteenth and first half of the twentieth century. As a passage south of the mountains on the way to Pittsburgh and a center for distributing the natural wealth of the Pennsylvania mountains, Harrisburg developed rapidly. A state capital and commercial hub building upon the steel, locomotive, and steam power of the American industrial age, as Pennsylvania grew, so did Harrisburg.

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[1] U.S. Department of the Interior, Historic American Engineering Record (HAER) No. PA-412, "Walnut Street Bridge," 1996, p. 4, Prints and Photographs Division, Library of Congress, Washington, D.C.; George P. Donehoo, *Harrisburg and Dauphin County* (Dayton: National Historical Association, 1925).

Paxton Creek Valley

Harrisburg was built atop a knoll adjacent to the Susquehanna, separated from the rolling hills of central Dauphin County by the depression of Paxton Creek valley. As the city developed during the latter half of the nineteenth century, the older downtown commercial and industrial districts grew eastward into the basin formed by Paxton Creek, while residential areas claimed the breezy heights above Harrisburg. A steep grade separated these heights, called Allison's Hill, from Cameron Street, the basin's major north-south artery. Mulberry Street ran east from downtown, across the lowlands of Paxton Creek and Cameron Street, and up that steep grade to Allison's Hill. A trip up to Allison's Hill from the heart of the city in the late 1880s was a daunting proposition. From Fourth Street, Mulberry crossed a bridge over an abandoned canal, through the switching yard of the Pennsylvania Railroad, across the tracks of the Philadelphia & Reading Railroad (P&R), across Tenth Street, over Paxton Creek, and finally across busy Cameron Street before ascending a steep grade toward Derry Street on the hill. As the city grew, and more trains, wagons and people attempted to negotiate the crossroads of Mulberry Street, an eventual contest over right-of-way was virtually assured.

Preceding an 1888 rendition of the Mulberry Street Viaduct in steel, two separate bridges carried Mulberry Street over the Eastern Division of the Pennsylvania Main Line Canal and Paxton Creek. Given the industrial nature of the area, the bridges were likely not very ornate. A utilitarian wooden trestle carried traffic over the canal and into the myriad tracks of the Pennsylvania Railroad's switching yard.[2] The bridge over Paxton Creek continued to serve traffic that came down from the railroad's overhead viaduct, built in 1888. It remains in use, carrying Tenth Street through the piers of the present concrete viaduct. The location of the earlier bridges and the road they carried, determined by train traffic, influenced commercial development along Cameron Street.

A bridge was needed across the entire Paxton Creek basin, however. Essentially a large swale with a creek running through the center, the basin — languid lowlands near a river but behind a bluff — became home to industrial and commercial enterprises. The heights above the Paxton Creek basin were separated from downtown by the gulf of the canals, railroad yards, factories, and warehouses.

The Fourth Street Overhead Bridge

Public opinion or liability persuaded the Pennsylvania Railroad to build an overpass to keep pedestrian and wagon traffic from crossing its switching yards just south of the Market Street Station platforms. In the spring of 1888, the Pennsylvania Railroad decided to make its switching yards located along Paxton Creek safer for traffic. Apparently at the behest of local officials, but also as a means to ease train switching, the railroad erected an overhead bridge of

[2] "Brevities," *Harrisburg Patriot,* 4 Sep. 1888.

its own design and construction to carry Fourth Street over its tracks and onto Mulberry Street.[3] Fourth Street was carried southeast from its original path above the Pennsylvania Railroad tracks, made a turn on the bridge, and headed northeast toward Mulberry Street. The Pennsylvania Railroad's structure ended before crossing the tracks of its competitor, the P&R, however.

Construction of the Fourth Street Overhead Bridge stirred the interest and imagination of citizens beset by the difficulties of crossing urban railroad tracks. Later that spring, the *Harrisburg Patriot* suggested that the bridge be extended over the adjacent tracks of the P&R, claiming, perhaps in exaggeration, that "those who use the bridge will be carried over one death trap into the jaws of another equally as dangerous."[4] This suggestion, the idea of an overhead bridge carrying traffic over the switching area south of the station, would eventually evolve into a plan to connect Fourth Street with Mulberry Street on Allison's Hill. After viewing the crossing, P&R officials deemed it unsafe, and indicated that something should be done about the hazard, but made no concrete offer to build an extension onto their competitor's existing bridge.[5] The idea of receiving title to the public right-of-way for the portion of Mulberry Street that ran through their switching yard no doubt appealed to the P&R officials, but they were in no hurry to spend money on a bridge. They chose to bide their time, waiting until public opinion and civic mandate forced the issue.

Yet even before the original viaduct over the Pennsylvania Railroad yard was completed, the issue became complex. A resolution was introduced to the city council on 30 July 1888, calling for the extension of the Fourth Street Overhead Bridge to Mulberry Street atop Allison's Hill.[6] The council's machinations regarding the bridge had the effect of confusing the issue for local authorities and railroad officials. The Pennsylvania Railroad's overhead bridge was already in use and nearly complete when, on 3 August, Mayor Fritchey instructed the P&R to have a crossing gate installed and planking laid at the foot of overhead bridge where it entered their yards.[7] It was soon revealed, however, that a committee of Harrisburg city council members had called at the P&R's general office about one week earlier, resulting in the company's proposal that the council move to eliminate the grade crossing entirely.[8]

Given their earlier commitment to assist in the construction of a bridge over their yards, P&R officials were willing to entertain plans for the bridge, but were unwilling to fund the entire project — extending the bridge to the hill top — themselves. The P&R was also unwilling to

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[3] "Fourth Street Overhead Bridge," *Harrisburg Patriot,* 10 Aug. 1888.

[4] "Why Not Extend It," *Harrisburg Patriot,* 6 Jun. 1888.

[5] "Reading Officials in Harrisburg," *Harrisburg Patriot,* 7 Jul. 1888.

[6] "Busy Sessions of Councils," *Harrisburg Patriot,* 31 Jul. 1888.

[7] "Local News," *Harrisburg Patriot,* 3 Aug. 1888.

[8] "The Overhead Bridge," *Harrisburg Patriot,* 8 Aug. 1888.

commit any money or resources until the nature and extent of bridge work had been decided by the city council. This was to be the critical sticking point.

On 10 August 1888, the Select Council proposed that the city of Harrisburg, with assistance from the Dauphin County, continue a bridge built by the P&R from the existing Fourth Street Overhead Bridge.[9] In the proposal, local funds intended for construction of a new market building would be used to build the publicly funded portion. The P&R would be responsible only for that portion of the overhead bridge that carried Mulberry Street over its yards. The council members in charge of this proposal, H. E. Kelly, H. E. Hershey, and James T. Walters, had gone so far as to solicit bids from reputable firms and solicited the P&R's cooperation in the matter. The Phoenix Bridge Company submitted the lowest bid, for $55,754, to construct approaches and the span of bridge from Tenth Street to the portion built by the P&R.[10]

At the next city council meeting, a competing proposal from council member Russell, representing the interests of merchants and manufacturers along Cameron Street, sought to strike the bridge proposal down. He argued that such a bridge would effectively isolate the businessmen and residents of industrial Paxton Creek valley. He further asserted that judicious improvements to Mulberry Street, where it descended a steep grade from Allison's Hill, would resolve the problem at less expense.

Cameron Street, with Harrisburg Railway's streetcar tracks down its center, had developed, in part as a consequence of access to downtown via Mulberry Street, into a bustling artery through the valley of trade and manufacture. First the Eastern Division of the Pennsylvania Main Line Canal, and later the Pennsylvania Railroad, had made the valley a site of vital commercial and industrial interest to Harrisburg. The political clout and input of business interests along Cameron Street and elsewhere in the Paxton Creek valley would help determine the form of an overhead bridge. On the other hand, residential interests were willing to cut off the industrial region, and safety issues related to crossing the Paxton Creek valley were their primary rallying cry. No doubt easier access to the city would enhance property values on the hill as well. Civic boosters were willing to support any issue that would enhance the capital city's status and edifice. Predictably, because it had to pay for at least part of the bridge, the P&R was mainly delaying the issue. If the matter of a bridge over its tracks dissipated in the meetings of the city council, so much the better. The battle between business interests of the Paxton Creek valley, the convenience and safety interests of Allison's Hill residents, communities to the east, civic boosters, and the P&R, was thus joined.

These varying viewpoints shaped the eventual construction of the Mulberry Street Overhead Bridge. Rather than a simple viaduct spanning a shallow region, the structure became literally and figuratively three different bridges. One section, the Pennsylvania Railroad's original trussed Fourth Street Overhead Bridge, was eventually connected to plate girder spans

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[9] "About the Overhead Bridge," *Harrisburg Patriot,* 10 Aug. 1888.

[10] "The Proposed Bridge," *Harrisburg Patriot,* 10 Aug. 1888.

built by the P&R. Added to this, a third section funded by the city carried Fourth Street traffic to Mulberry Street on the hill, and provided an access ramp to Cameron Street below. The completed structure allowed traffic to move into and out of the industrial basin from either Allison's Hill or Harrisburg, or to traverse the industrial basin and railroad crossings altogether.

A structure thus defined would, however, not be complete until the fall of 1890. Political machinations, discussions, pleas, and delays would postpone adoption of a funding ordinance until the spring of that year. Debate over the bridge continued in council for much of the summer and into the fall of 1888. During the winter and spring of 1889, the issue lingered on, continually referred into and out of committee, always meeting with general approval, so long as the bridge included the curious access ramp. Though a majority of the public and politicians wanted the project to begin, no individual or interest group seemed willing to tackle the problem of funding.

Local boosters, among them the editor of the *Harrisburg Patriot,* agitated for the extension of what was then known as the Fourth Street Overhead Bridge to Mulberry Street on the hill opposite.[11] With passionate and eloquent support, the issue of an overhead bridge did not pass quietly. During June of 1889, the issue was finally brought before the council with the sponsorship necessary to see it through to the end. City council member Stamm, possibly in response to increased public interest generated by articles in the *Patriot,* introduced an ordinance allowing the sale of bonds to finance construction of an overhead bridge at Mulberry Street.[12] Following much debate, the council members decided to attach a referendum, allowing the citizens of Harrisburg to vote on any increase of public debt. As sponsor of the ordinance, Stamm was a vocal and devoted supporter. He continually brought the measure before his peers on the council, only to have it laid over or referred to committee, and helped resolve disputes between representatives of the Second Ward and business interests on top of Allison's Hill, thus smoothing the way for a bridge by preserving access to areas beneath it.[13]

About the same time that Stamm formalized the issue of an overhead bridge connection between the hills east of Harrisburg and downtown, the unbuilt structure's name changed from Fourth Street Overhead Bridge, to Mulberry Street Overhead Bridge, reflecting the longer crossing to Allison's Hill. Given his involvement to help resolve issues surrounding the Mulberry Street Overhead Bridge during the summer of 1889, Stamm's subsequent request to lay over the issue must have perplexed the community.[14] Members of the select city council, in secret meetings, had begun negotiating with representatives of the P&R for rights to build a bridge over the Susquehanna from the vicinity of Paxton Street. In exchange, the select

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[11] "Cannot Cross the Bridge," *Harrisburg Patriot,* 29 Dec. 1888; "The Overhead Bridge," *Harrisburg Patriot,* 1 Jul. 1889. See also numerous reporting of city council minutes for all dates referenced herein.

[12] "The Overhead Bridge"; "It Has Passed," *Harrisburg Patriot,* 29 Oct. 1889.

[13] "Common Council," *Harrisburg Patriot,* 14 Sep. 1889; *Harrisburg Patriot,* "It Has Passed."

[14] *Harrisburg Patriot,* "Common Council."

committee had stipulated that the P&R contribute to the public works of Harrisburg, attaching a pedestrian walk to its railroad bridge across the Susquehanna, and pedestrian overpasses over downtown railroad tracks. Finally, on 29 October, only after a "rough and ready set-to," the ordinance passed the common council.[15]

Serious issues divided members of the Bridge Committee and officials of the P&R.[16] To improve access to the city from the south via a bridge crossing the Susquehanna at Paxton Street, the Bridge Committee demanded the railroad trestle include two pedestrian walks at least five feet in width. Given the unpleasantness of standing five feet from a passing train, the idea of combining foot and rail traffic on the same bridge seems questionable. Moreover, plans were well under way to begin construction of the Walnut Street Bridge nearby, a Susquehanna crossing much more conducive to foot traffic.[17] Not surprisingly, the P&R did not agree and declined the Bridge Committee's proposal.[18] The railroad indicated that it would simply cross the river at Steelton and enter Harrisburg from the southeast, if at all. In retrospect, it seems the Bridge Committee was simply feeling out the P&R's bargaining limits. They had discovered the alternative before the railroad, a more costly and circuitous southern route. Once an expensive addition to the Susquehanna bridge was denied by the railroad, the committee proceeded to press the Mulberry Street bridge as a less extravagant demand.

Select Council president Smull argued to amend the ordinance to require a general referendum seeking public approval of the bridge before funds could be raised.[19] This would both delay the bridge issue until secret negotiations with the railroad could be concluded with terms favorable for Harrisburg, and determine public opinion in general, not simply that of hill-top bridge advocates. Such a referendum would also spread the responsibility for funding the bridge among the entire community rather than just the city council, while pressuring authorities to act both rapidly and judiciously in the interest of meeting public demand; should it fail, it would absolve the council from accusations of inaction. The Bridge Committee then modified its demands to allow the P&R to cross the Susquehanna at Paxton Street if it continued the overhead bridge built by the Pennsylvania Railroad — from Fourth Street over the P&R tracks, the Harrisburg Railway's street car tracks, and Cameron Street — to Mulberry Street at the top of Allison's Hill.[20] These demands went back to the P&R for assessment.

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[15] "It Has Passed One Branch," *Harrisburg Patriot,* 29 Oct. 1889.

[16] "Still They Delay Action," *Harrisburg Patriot,* 14 Nov. 1889; "A Foot Bridge Demanded," *Harrisburg Patriot,* 22 Nov. 1889.

[17] *Harrisburg Patriot,* "A Foot Bridge Demanded."

[18] "The Bridge Committee," *Harrisburg Patriot,* 30 Nov. 1889.

[19] "Both Branches of Council," *Harrisburg Patriot,* 10 Dec. 1889; "Pushing For A New Bridge," *Harrisburg Patriot,* 27 Dec. 1889.

[20] "The Bridge Committee," *Harrisburg Patriot,* 30 Nov. 1889.

Remonstrance from P&R officials regarding the demand for public works in exchange for right-of-way only strengthened the resolve of the Bridge Committee. A headline from 24 December proudly proclaimed that "The Bridge Committee Will Not Yield This Time."[21] Whereas the issue of foot walks on the Susquehanna bridge was dropped with barely a whimper, the Bridge Committee, with the full support of the city council, stood firm on its demand for public improvements in exchange for railway right-of-way into south Harrisburg. The "crown jewel" of the improvement package, which also included overhead service at Market Street and the extension of approaches to some lesser bridges, was construction of the Mulberry Street Viaduct.

Aware of the benefits of linking the viaduct's construction to the right-of-way grant, citizens of East Harrisburg held a public meeting resulting in a resolution on behalf of the ordinance — drafted and agreed to by the citizens of the hill — to be presented by twenty-five representatives to the city council when next they met. The Common Council, however, bowing to a threat from the P&R to bring its line in through Steelton, adopted a resolution granting the railroad access through the south of Harrisburg without provisions for extension of the Fourth Street Overhead Bridge to Mulberry Street. Still, influential members of the Select Council held firm to the idea of denying access to the P&R without some concessions.

The pressure to get on with the bridge was coming full blast from Allison's Hill. Nevertheless, Smull argued that the ordinance to fund the overhead bridge project with civic funds must be passed with consideration of proper order. In addition, he sought to defend himself against charges that he was intentionally delaying the issue in the hope of finding funds for the bridge in the P&R's coffers. Select Council Members, especially Smull, seemed convinced that the railroad would bow to the Bridge Committee's demands.

Ultimately, the P&R agreed to build a bridge over its tracks to the edge of Tenth Street, a short block from the main thoroughfare of Cameron Street. A resolution to fund the remainder of the bridge at public expense followed. As finally resolved during the winter of 1890, the issue resembled agreements nearly met in 1888.[22] The P&R would build the spans covering its own territory, linking to the Overhead Bridge built by the Pennsylvania Railroad in 1888, and the city would build a bridge and ramp connecting both hill and valley to the heart of the city. On 1 April 1890, the contract for Harrisburg's portion of the Mulberry Street Overhead Bridge was announced. Dean and Westbrook, Engineers and Contractors, sales agents for the Phoenix Bridge Company, began work during late summer on a truss-like form similar to the Walnut Street Bridge it was then building across the Susquehanna.[23]

The development of the first Mulberry Street Overhead Bridge is an example of engineering adapted to politically charged environment of 1888 and 1890. The original overhead

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[21] "The Secret Meeting is Over," *Harrisburg Patriot,* 24 Dec. 1889.

[22] "The Bridge Ordinance," *Harrisburg Patriot,* 31 Dec. 1890.

[23] "Fire Causes Estimated Loss of $150,000," *Harrisburg Patriot,* 13 Oct. 1903.

bridge reached over the tracks of the Pennsylvania Railroad (which were partially atop the filled Eastern Division Canal) and little further. It allowed safe passage to travelers and citizens heading to the suburbs located atop the hills above East Harrisburg. When the overhead bridge was extended to completely span the low land between Harrisburg proper and Allison's Hill, it crossed over the Pennsylvania Railroad's switching yard, the P&R tracks, Tenth Street, Paxton Creek, the Harrisburg Railway tracks, and Cameron Street. It spanned the gulch between Fourth and Thirteenth streets with a spidery conglomeration of steel trusses, plate girders, and columns.

Construction of the Mulberry Street Concrete Viaduct

On 12 October 1903, a fire begun in the Boll Manufacturing Company, one of the businesses located beneath the Mulberry Street Viaduct.[24] Despite barrels of water placed at intervals along the bridge deck for extinguishing fires, wood planks forming the roadway caught fire and burned completely.[25] The steel structure remained intact, but was too weakened to accept full traffic loads without extensive repairs. What remained of the overhead bridge was repaired during the winter of 1903.

Public agitation for a new bridge prompted the city council to designate funds for a replacement structure. The *Harrisburg Patriot* asserted that the old Overhead Bridge, a conglomeration of differing structural forms and repairs, was unfit for use. The article argued,

> Any person driving over the bridge or standing down in busy Tenth Street or on the city's great through highway, Cameron Street, when a team is passing over the structure can hear that it is not strong enough for the traffic. It does not need expert technical knowledge to realize that.

As formed by the confluence of the public interest, the railroad companies, and business interests on Cameron Street, the bridge had been quite a success. During the winter of 1906, deliberations concerned not whether to replace the bridge but, rather, how money for a replacement could be arranged. Everyone, even city council members, seemed to agree that the Mulberry Street Overhead Bridge was vital to the city's prosperity and efficient traffic flow.[26] The city council debated and resolved to build a new overhead bridge of concrete, to be called the Mulberry Street Viaduct.

Following passage of a $200,000 bond issue, the task of designing a new viaduct to replace the burned structure was given to city engineer James H. Fuertes. The difficulties involved were considerable. Fuertes had to design a bridge measuring 2,400'-0" in length, including approaches and abutments. The spans of elevated roadway totaled 1,841'-0", with an

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[24] *Harrisburg Patriot,* "Fire Causes Estimated Loss of $150,000."

[25] Richard H. Steinmetz and Robert D. Hoffsommer, *Harrisburg: a Photographic History* (Harrisburg, Pa.: Stackpole Books, 1976), 76.

[26] "Strong Bridge is Vital to Harrisburg's Future," *Harrisburg Patriot,* 24 Oct. 1905.

elevation change, an exit ramp halfway along the viaduct, and a curved entrance; to be built without hindering railroad traffic below. Formidable fiscal obstacles narrowed design parameters: with only $200,000 appropriated for construction, the bridge had to be strong, go up quickly, and use inexpensive materials. Against these seemingly impossible design constraints, Fuertes pitted the developing science of reinforced concrete.

The bridge was formed and poured according to a rigid schedule during the months of September through December.[27] The forms were built to hold half an arch on either side of the pier during pouring. Cantilevering half-arch spans from the piers during pouring allowed traffic to continue unhindered below. This also allowed the piers to be slender in relation to their height, since during construction they were not required to take the thrust of arches beyond those directly attached.[28] Cantilevering the arches, essentially balancing the weight of half-arches on either side of each pier until they met adjoining half-arches springing from adjacent piers, avoided construction of abutments or massive piers to resist horizontal thrust, as would result from construction of whole arches in a linear fashion. Cantilevering amounted to constructing a series of independent Ts with their top bars just touching. Much of the Mulberry Street Viaduct's aesthetic success can be attributed to the resulting light appearance of the piers and arches.

When the Ts were connected, horizontal members began thrusting load downward into the piers as arches rather than supporting loads as cantilevered beams. The Ts acted as beams in the unfinished structure, but to support a roadway, they needed the additional strength of the arch form. To accomplish this transition, Fuertes designed the arches with a gap above where they met atop each pier. During construction, reinforcing rods crossed these transverse gaps to hold the half-arches cantilevered off either side of each pier.[29] Once all the half-arches met at mid-span, essentially when pouring for the support system was complete, the rods across the pier tops were severed and they became arches in compression. The gaps then became expansion joints. By using this system of erection, the piers were at no time required to accept the thrust loading of an arch without a countering thrust from adjacent arches. Designing piers only large enough to accept the weight of the arches and roadway, without the thrust of the unfinished structure as it advanced across the span, yielded huge savings in pouring time and material.

The key to constructing a cantilevered concrete bridge according to such difficult specifications hinged upon two factors: clever form work, and a design that allowed the half-arches' weight to be supported by each pier until they were met by adjoining arches. Clever form work design, taking full advantage of the economies of material and time offered by the

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[27] "The Mulberry St. Reinforced-Concrete Viaduct, Harrisburg, Pa.," *Engineering News* 63, No. 2 (13 Jan. 1910): 43.

[28] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 39.

[29] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 39.

cantilever erection method, also permitted rapid pouring and easy re-use.[30] Meeting these criteria was all the more difficult in the Mulberry Street Viaduct, as the forms had to adapt to differing span lengths and be durable enough to be rapidly moved among the nineteen piers. In addition, the curved approach required forms capable of holding spandrels of differing lengths at differing skew angles.[31]

To solve the difficulties of pouring concrete, Fuertes turned to the versatility of steel. Forms consisting of trough-shaped steel plate girders were assembled from three separate sections, and attached between two piers for pouring. The outer two sections increased in depth as they approached the piers, forming an arch-shaped trough. As shorter spans were cast, the flat-bottomed trough composing the center section was cut down to decrease the overall length of the form.[32] The U-shaped trough also permitted the addition of finish form work on the bottom of the trough to form the shallow, gradual arcs of the three-centered arches used throughout the viaduct.[33] The form work was also specified with an interior finish of smooth steel to ease removal and final concrete finishing. It was fabricated using countersunk steel rivets. Because of the modifiabilty engineered into each form, only twenty-four separate forms were required for arches of various lengths.[34]

To further lighten the substructure required, the deck system had to be both light and rigid. It consists of cast transverse girders resting directly atop the arch spandrels, carrying a reinforced floor slab 6" thick. The original wearing surface of the deck was 2" of asphalt atop loose fill and 1" of binder.[35] Along the edges of the deck, the ends of each transverse beam cantilever out to support the outer halves of 8'-0"-wide sidewalks.

Description of the Mulberry Street Viaduct

The Mulberry Street Viaduct, when completed, was lauded as one of the longest reinforced concrete bridges in the world. According to *Engineering News,*

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[30] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 42.

[31] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 35, 42.

[32] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 40-42.

[33] Three-centered arches have arcs whose radius tapers from smaller to larger from the springing of the arch toward the crown. Usually, the two outside arcs are described by a center with a radius of a common length. The radius of the center arc of the arch is usually larger than the two outside arcs, creating an arch which is flatter than a simple semi-circular one.

[34] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 42.

[35] Modjeski and Masters, "Rebuild Bid Plans," 1957, bridge maintenance files, BMS No. 22-3012-0080-0233, PennDOT District 8-0, Harrisburg, Pa.

> 1,841 ft. long, 78 ft. above the ground at its highest point and carries on 19 arches a 28-ft. roadway and two 8-ft. sidewalks. From a point near its east end and at the foot of the hill at that abutment, there is an inclined approach viaduct 602 ft. long made up of five of 5 arches, and carrying a 24-ft. roadway and a 6-ft. sidewalks, all on a 6.9% grade.[36]

The bridge also, like the steel Fourth Street Overhead Bridge before it, has a curved approach on a 3 percent grade.[37]

The viaduct traverses Paxton Creek valley with nineteen spans ranging in length from 40'-0" to 100'-0". The curved section of roadway leading Fourth Street from Harrisburg onto the bridge is composed of spans with arch ribs varying in length and skew according to the irregular arrangement of the piers between the railroad tracks below. The remaining arch ribs, supporting the straight portion of the road, have equal lengths between spans.[38]

These nineteen spans combine to carry the viaduct over three railroads, two roads, and one creek. Numbered from northeast to southwest, the viaduct traverses Cameron Street and the former route of the Harrisburg Railway between piers 2 and 3. Between piers 4 and 5, Paxton Creek meanders toward the Susquehanna. Further down, Tenth Street runs between piers 6 and 7. Major railroads, the P&R (now Conrail) and the former Pennsylvania Railroad (now Amtrak), occupy much of the remaining space between piers. The former moves trains between piers 9 and 11, and the latter between piers 13 and 18.[39]

To anchor the structure during construction and help absorb the thrust of a roadway set on a grade, an intermediate abutment fills in under the roadway where the access ramp attaches between piers 8 and 9. This box is essentially one huge pier, 30'-0" wide, without arches or openings. It is filled with vertical concrete walls running parallel to the roadway, providing strength with a minimum amount of concrete.[40] The access ramp stretches from midway along the bridge, southeast over Tenth Street and Paxton Creek, to intersect Cameron Street.

Each span is composed of four arch ribs, the outer two pairs braced laterally via transverse slabs cast between them toward each springing. They rest on an impost cast atop rectangular reinforced concrete piers. These slender piers rest on a solid plinth, supporting a skewback that receives the thrust of the arches. Atop the pier, integral with the solid skewback, a cornice protrudes on all sides, breaking the line of the arches and probably serving as a form support during construction. Above the arch but beneath the cornice, a line of decorative corbels appear to "support" the mass of the skewback. The taller piers are pierced by an arch; the shorter

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[36] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 38.

[37] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 38.

[38] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 38-9.

[39] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 38-9.

[40] *Engineering News,* "The Mulberry St. Reinforced-Concrete Viaduct," 41.

piers are reinforced with a plain horizontal beam cast halfway up the piers. On the piers pierced by arches, the decoration recalls the proportion and form of Roman architecture. Parallel to and just above the line of the semicircular arch, a line of molding breaks up the tympanum of the pier. On the face of the columns formed on either side of the piers with arches, two simple square pilasters are cast in half-relief.

Atop the structure, corbels once supported the original cast railing posts and lamp piers, while the transverse floor beams formed smaller corbels beneath the sidewalks. Lamp posts of cast concrete carried spherical globes at most piers, with clusters of spherical globes at the main piers and abutments. Iron pipe handrails, since replaced, were set into the railing posts and light piers in three vertical rows along the entire bridge. The entire structure represents an effort at aesthetic integration considered quite successful at the time.

The Mulberry Street Viaduct was a brilliant structure for many reasons. To those interested in civic prestige and promotion, it represents a successful addition to the City Beautiful movement in Harrisburg. As an engineering example, it admirably fulfilled the contradictory parameters of rapid construction, sophisticated design, and the use of modern, inexpensive materials, with the assistance of steel reinforcing rods and form work. Finally, as a monument to citizens' dispirit demands, the Mulberry Street Viaduct assumed the unusual, three-bridge-in-one form of its predecessor, the Fourth Street Overhead Bridge.

Rehabilitating the Viaduct

Though originally considered impervious to the elements, indeed virtually permanent, reinforced concrete bridges have aged less gracefully than those of other materials. Beginning in 1923, the Mulberry Street Viaduct has needed work on numerous occasions. That year, the arch ribs were sprayed with gunite, likely to control spalling. The sidewalks were rebuilt entirely in 1933 and again in 1957. Also in 1957, during a major overhaul conducted by Modjeski and Masters, the railings, roadway, and pier fascia were replaced. Considerable attention was paid to the bridge's drainage system, likely the cause of much of the spalling, so scuppers and down spouts were also reset or enlarged throughout the structure. The piers were also waterproofed, a process that might have included as much moisture as it excluded. In 1982, the bridge was overhauled again. Piers were patched where spalling exposed reinforcing bars in numerous places, the railings and sidewalks were repaired, and again the roadway was replaced.[41]

[41] Modjeski and Masters, "Rebuild Bid Plans."

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